

*Speculum Nauticum.*  
A  
**LOOKING**  
**GLASSE**  
FOR  
**SEAMEN:**

Wherein they may behold a small Instrument called the Plain SCALE : whereby all Questions Nauticall , and Propositions Astronomicall are very easily and demonstratively wrought.

*Published for the use and benefit of such as will  
make good use of it.*

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By *John Apley*, Student in Physick, and Practitioner of  
the *Mathematicks*, in the Citie of *London*.

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*The fift Edition corrected.*

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**L O N D O N,**  
Printed by *Thomas Harper*, and are to be sold by *George Hurlock*, at his shop at *Saint Magnus* corner.  
1655.

Specimen of the

# LOOKING

GLASS

FOR

SEAMEN:

Wherein they may behold a small but

perfect representation of the whole of the

Questions Nautical, and Propositions Astro-

nomical, are very easily and demon-

strated by the

Illustrations for the use of Seamen, and  
made good use of it.

By John Knap, Surgeon in Physick, and Practitioner of  
the Chirurgery, in the City of London.

The first Edition, 1711.

LONDON,

Printed by Thomas Wapley, and are to be sold by G. Wapley,  
at his Shop at the Sign of the Ship in Cornhill.

1711



TO THE WORSHIPFULL  
THE MASTER, WARDENS,

And Assistants, of the *Trinity House*  
in *Deptford Strand*.



Albeit ) Right Worship-  
full ) there be more es-  
sential natures contain-  
ed in each part both  
of this *Macrocosme*, &  
*Microcosme*, existing in  
their absolute being, than the understand-  
ing of man can fully apprehend; yet I  
doubt not, but those which may with  
labour & diligence be known, & those  
also which of ingenious spirits and no-  
table wits have been invented, and by  
them artificially & methodically taught,  
(tending not onely to manifest profit in

A 2 -

the

*The Epistle*

the Common-wealth, but also to the great increase and setting forth of Gods div:n: power, wisdom, goodness, providence, and increase of Virtue, ought of all men to be imbraced, ( and especially of those which have any government, publik charge, or authority in the Common wealth. ) In regard that the neerer men approach to such excellent Vertues, the neerer (without doubt) do they come unto goodness, to felicity, and to God himselfe. Hence saith the Prophet (unto men seated in eminent places) *Dixi vos dii estis*, so that those which either through arrogance, or ignorance deride, & contemne those Arts ( which with great dexterity, care, and industry have bin found out, and left unto us by the love of our Predecessors ) doe both offer contempt unto the goodnesse of God, and do much endamage and annoy all humane society. So on the contrary part, they that doe by all means further those



*Dedicatory.*

those so profitable Disciplines do both  
render true honour unto God, and do  
greatly advance the good of the Com-  
mon-wealth wherein they live. Now in  
regard there is no study ( Divinitie ex-  
cepted ) wherein the wit of man may be  
better employed then in the motion of  
the stars, and in the knowledge of their  
situation, place, and being, together  
with their wonderfull effects; In regard  
whereof I was incited to imploy some  
of my time in the study thereof, and at  
last considering that of the Orator, that  
*Non solum nobis nati sumus, &c.* We are  
not borne for our selves only, but our  
friends challenge a part in us, and our  
Countries come in for a share, especially  
those honours and graces of our Coun-  
trei, those that traffique in the deepe, and  
have their businesse in the great waters,  
those that are unto this Island as a wood-  
den wall, the Sea-chariots, and the hor-  
les of England: these, I say, may claime  
justly

justly to the fruits of our labours, whatsoever they be which have not altogether been abhorrent from the Mathematicall studies: considering this, I could do no lesse than bring in this my mine into their treasury, and *Si quid ars mea officere possit*, (if my skill can stand them in any stead) to further that so much deserving Science of Navigation. Accept therefore, I beseech you, this yong sonne of my studies, this little handfull of paper, wherein is contained not *Anacreons* wanton Odes, or *Ovids* lascivious Elegies, the incendiaries of lust, but a pure spark of chaste Vestal fire, a small part of the Mathematicks dedicated from a serviceable affection to your VVorships, that under the shield of your protections it may live secure, from the desperate stab of criticall persons, and envious spirits, who not onely like Soatling *Satyres* deride and contemne those so liberall Sciences, but  
swallow

*Dedicatory,*

swallow up with despite (if it were possible) the professors thereof. For rescue from such malignant spirits my Booke flies to the shadow of your favour, which if you shall afford unto it, my labours shall be all sacrificed unto you, and I rest,

*Your Worships bound servant,*

**JOHN ASPLEY.**

*Your friend in affection*

*John Aspley*



To the Reader.



Having ever since I came  
unto understanding  
(courteous Reader)  
practised my selfe in the  
Mathematicall studies:  
and having attained  
unto my desires therein, I am willing to im-  
part some of that knowledg which God hath  
bestowed upon me, unto the open view of  
the World: for the manifestation wherof, I  
have freely given unto thee this smal Book,  
being the first fruit of my labours, containing  
such Astronomicall and Nauticall questi-  
ons as are wrought by the plaine Scale:  
which if I should finde to receive as free  
acceptance from thee, expect more of  
my labours in the same kinde, and untill  
then I rest,

Thy friend in affection,

JOHN ASPLEY.

*per.*



*Speculum Nauticum.*  
OR THE  
**SEAMANS**  
**GLASSE.**

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*THE FIRST BOOK.*

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CHAP. I.

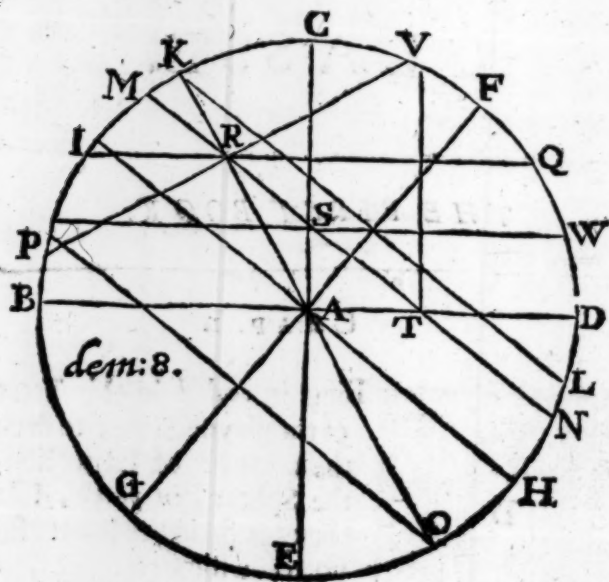


Being intended in this Treatise  
of the playne Scale, to declare  
the manner of Projection of  
the Sphear, *in plano*, I have  
thought fitting first, to shew  
upto you some terms of *Geome-*  
*try* which are necessary for the  
unlearned to know (for whose  
sake chiefly I write this Treatise) before they enter  
into

into the definition of the Spheare. First, therefore I intend to relate unto you, what a point or prick is, and afterward a Line both right and crooked, and such sorts thereof as are appertinent unto the operations and use of this Scale.

*Punctum*, or a Point, is the beginning of things, or a prick supposed indivisible, void of length, breadth, and depth; as in the figure following is noted by the Point or Prick A.

*Linea*, or a Line, is a supposed length, or a thing extending it selfe in length, not having breadth nor thicknesse, as is set forth unto you by the Line B A D.



*Parallelia*, or a Parallell Line, is a Line drawne by the side of another Line, in such sort that they may be



be equidistant in all places. And of such Parallels two only belong unto this work of the plain Scale, that is to say, the right lined parallell, and the circular Parallell.

Right lined Parallels, are two right lines equidistant one from another, which being drawn forth infinitely, would never touch or meete one another, as you may see in the figure where the line H. I. is Parallell unto the line C.E. and the line G.F. is Parallell unto them both.

A circular Parallell is a Circle drawn eyther within or without another Circle upon the same Centre, as you may plainly see by the two Circles B.C.D.E. and X V.Y.W. These Circles are both drawne upon the Centre A. and therefore are parallell the one unto the other. There is another kind of Parallell also, which is called a serpentine Parallell, but because it is not belonging to the use of this Scale, I will omit it and so proceed unto the rest.

*Perpendiculum*, or a perpendicular is a Line rayed from, or let fall upon another Line, making equall angles on both sides, as you may see declared in the figure, wherein the Line A. C. is perpendicular unto the line B.A.D making equall angles in the point A.

*Diameter Circuli*, or the Diameter of a Circle, is a right Line drawn thorow the Centre of any circle, in such sort that it may divide the Circle into two equall parts, as you may see the line B.A.D. is the Diameter of the Circle B.C.D.E. because it passeth thorow the Center A. and the two ends thereof do divide the Circle into two equall parts, in the two extremis B. & D making the semicircle B. C. D. equall unto the semicircle D. E. B.

*Semidiameter circuli*, or the Semidiameter of a Circle,

B a

cle,

ele, is halfe of the Diameter, and is contained betwixt the Centre, and the one side of the Circle, as the Line A D, in the Semidiameter of the Circle B C D E

*Semi-circulus*, or a Semi-circle, is the one halfe of a Circle, drawne upon his Diameter, and is contained upon the Superficies, or Surface of the Diameter, as the Semicircle B C D, which is halfe of the Circle B C D E, and is containd above the Diameter B A D.

*Quadrans circuli*, is the fourth part of a Circle, and is containd betwixt the Semidiameter of the Circle, and a line drawn Perpendicular, unto the Diameter of the same Circle, from the Centre thereof, dividing the Semicircle into two equall parts, of the which parts, the one is the quadrant, or fourth part of the same Circle. As for example, the Diameter of the Circle B C D E, is the Line B A D, dividing the Circle into two equall parts: then from the Centre A, raise the Perpendicular A C, dividing the Semicircle likewise, into two equall parts, so as A B C, or A C D, the quadrant of the Circle B C D E, which was desired.

CHAP.

CHAP. II.

*The manner how to rayse a Perpendicular from  
the middle of a Line given.*



Draw first a ground Line whereupon you would have a Perpendicular rayfed, then open your Compasses unto any distance (so it exceed not the end of your Line,) placing one foot of the said Compasses, in the point from whence the Perpendicular is to be rayfed, and with the other foot make a marke in the Line on both sides, then removing your Compasses, unto any other distance that is greater, and set one foot therof, in one of the marks, and with the other foot make a marke over the middle point, then with the same distance of your compasse, set one foot in the other mark upon the Line, and with the other foot make another arch of a Circle over the middle point, so that it may cross the first arch, and from the meeting of these two arches, draw a right Line unto the middle point, from which the perpendicular was to be rayfed, which Line shall be the Perpendicular desired.

Example, suppose your Base or ground Line whereupon a Perpendicular is to be rayfed by the Line F L K, and from L, the Perpendicular is to be rayfed, set one foot of your Compasses in the point L, and with the other, make the marks G, and M, on both sides of the point L, then opening your Compasses wider, set one foot in the point M, and with the other draw the arch S, over the point L, then with the same distance of your Compasses, set one foot in G, and with

B 3

the

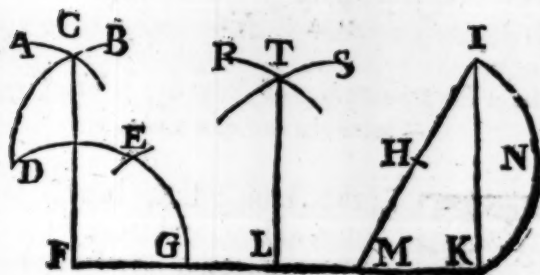
the other make the arch R. crossing the arch S. in the point T. then from T. draw the Line T. L. which Line is Perpendicular unto the Line F. L. K. from the point L, which is the Perpendicular desired,

### CHAP. III.

*To let a Perpendicular fall from any Point assigned, unto the middle of a Line.*



Et the line whereupon you would have a Perpendicular let fall, bee the Line F L K, & the Point assigned, to bee the point T, from whence you would have a Perpendicular let fall, upon the Line F L K. first set one foot of your Compasses in T, & open your Compasses unto any distance, so that it be more than the distance T L, which here we suppose to be the distance T M, then make in the Line F L K, the marks G, and M, then with your Compasses, take the one halfe of G M which is in the point L, then from L, draw a Line unto the point T, so the Line T L, shall be the Perpendicular, which was desired to be let fall from the assigned point T, unto the middle of the Line F L K.



CHAP. IV.

*To raise a Perpendicular upon the end of a Line.*



Uppose the Line whereupon you would have a Perpendicular rayed, be the line  $FLK$ , and from the point  $F$ , a Perpendicular is to be rayed: first open your Compasses unto any distance, which here wee put to bee the distance  $FG$ , & set one foot of your Compasses in the point  $F$ , and with the other draw the arch  $DEG$ , then set one foot of your Compasses in the point  $G$ , and with the other draw the arch  $BE$ , then placing one point of your Compasses in  $F$ , with the other draw the arch  $DB$ , then place your Compasses in  $D$ , and with the same distance, draw the arch  $AB$ , cutting the Arch  $DB$ , in  $C$ , then draw a Line from  $C$  unto the end of the Line  $FLK$ , unto the assigned point  $F$ , so shall the Line  $CF$ , be a Perpendicular, rayed from the end of the Line  $FLK$ , and from the assigned point  $F$ .

CHAP.

## H A P. V.

*To let a Perpendicular fall from any point assigned  
unto the end of a Line.*

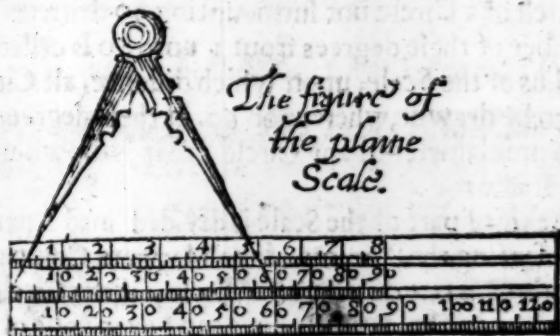


Et the Line F L K, bee the Base or ground Line, and from the point I, a Perpendicular is to be let fall upon the end of the Line K, first from the assigned point I, draw a Line unto any part of the Base, which shall be the Line I H M, then finde the middle of the Line I M, which is at H, place therefore one foot of your Compasses in the point H, and extend the other unto I, with which distance draw the arch I N K, upon the Centre H, cutting the Base or ground line in the point K, then draw the Line K I, which Line shall be the Perpendicular desired:

**N**OW I doubt not but you understand the way to let fall, or to rayse, any manner of Perpendicular Line, eyther from, or upon any part of a Line: therefore now I intend to proceed unto the maine point here aimed at, which is, to declare, and make known unto you the several operations performed by the plain Scale, which though it bee in use with very few, yet it is most necessary with Sea-men, because all questions in Navigation are therby easily and plainly wrought. And also all questions in Astronomy (belonging unto the expert and industrious Sea-men) may both speedily and easily be wrought by the same Scale: in regard wherof I have declared in this little Book, that knowledge (which God hath beene pleased



sed to bestow upon me) concerning the necessary use and practice therof; hoping that you will as kindly accept it, as it is freely offered unto your courteous considerations.



CHAP. VI.

*Of the description of the Scale.*



His Scale usually is divided into three parts, the first wherof is a Scale of equall Leagues, divided into Degrees, or Leagues from 1 unto 100. and upwards, at your pleasure, and numbred with 10 20 30 40, and so forth unto the end. All these divisions are equall one unto another, and is in use for to measure the leagues that any ship hath run upon any course, or the leagues that she hath raised or depressed the Pole, or departed the Meridian, as in the worke hereafter shall be more fully declared.

The second part of the Scale, is the single Corde  
C of

of a Circle, or the Cord of 90, and in dividing into 90, unequall divisions, representing the 90, deg. of the Quadrant: and are numbred with 10, 20, 30, 40. &c. unto 90. This Cord is in use to measure any part, or arch of a Circle not surmounting 90 degrees: The number of these degrees from 1 unto 60 is called the Radius of the Scale, upon which distance, all Circles are to be drawne, whereupon 60. of these degrees are the Semidiameter of any Circle, that is drawn upon that Radius.

The third part of the Scale is divided into 8 parts, representing the 8 points of the Mariners Compasse, contained in one quarter of a Circle, if the Circle be drawn upon the same Radius, and every one of the aforesaid points, is (for exactnesse sake) subdivided into 8 smaller parts.

I have likewise caused two other lines to be placed upon the back side of the Scale, which I doe call the first and second Lines of Longitudes: the first is divided into 20 unequall parts, or leagues, which 20 Leagues are equall unto the Cord of 90. The use of this first Line of Longitude, is to shew how many Leagues and Miles in any Parallell doe answere unto one degree of the Equinoctiall.

The second Line of Longitude is divided into 100 proportionable parts, or into 100 unequall Leagues and every league is subdivided into miles, and halfe miles. The use of this line is thus: When you have found by the first Line of Longitudes, how many Leagues and Miles doe answere unto a degree of the Equinoctiall in any latitude you desire: this second line will shew you how many degrees any number of leagues in that Parallell, will answere unto a degree in the Equinoctiall Circle.

Thus

Thus having shewed you the parts of the Scale, and unto what use they doe generally serve, I will proceede to declare the particular use thereof, in the Art of Navigation, as followeth.

CHAP. VII.

*To find how much any Ship hath raised or depressed the Pole, knowing the course she hath made, and the leagues she hath sayled.*



He Course is Southwest and by South, the Leagues sayled are 100, the difference of Latitude is demanded.

In the first Demonstration, draw first the Line A B, and upon the Centre A, raise a Perpendicular A F. Then opening your Compasses unto the Radius of your Scale, and set one Foot thereof in the Center A. and with the other draw the Arch K C B, then in regard your course is Southwest & by South, that is three points from the South, take three of the eight points of the Compasse with your Compasses, and place them from K, unto C, then draw the Line A C D, and place the distance of the Leagues you have sayled (which) are 100. upon the Line A C D, from A, unto D. Then from D, draw the Line D F. Parallell unto A B, cutting the Meridian A K F, in the point F, then take the distance of F A, and apply it unto the Scale of equall Leagues, and you shall find it just 83 Leagues, or 4 Deg. 9, Min. which are the degrees you have altered the Latitude, which degrees and minutes (if the Latitude from whence you departed, be South) must be added unto the Latitude

C<sub>2</sub>

from



and set one foot of your Compasses in the point A, and with the other draw the arch G H, cutting the Line F D, in D, so shall the distance D F, bee the distance of the Meridian, from the Meridian, from whence you departed, which (being applyed unto the Scale) is 56 leagues. Then in regard you sayled from the North Parallell of 56 deg. and 5. min. untill you had depressed the Pole 4 deg. 5. min. Subtract therefore 4 deg. 9. min. from 56 deg. 5 min. and there remaineth 51 deg. 56. min. which is the latitude of the place you are in, and in that Parallell have you departed the first Meridian 56 leagues. Then opening your Compasses unto 51 deg. 56. min. of your Cord, and apply it unto the first Line of Longitudes, and you shall finde that 12 leagues and one mile (in that Parallell) doe alter one degree of Longitude. Then set one foot of your Compasses in the second Line of Longitude, at 12 Leagues, one Mile, and extend the other unto one degree of that Line; then with that distance set one foot of your Compasses in 56 leagues of the aforesaid Line, and the other will extend unto 4 degrees 33 min. which is the distance Meridionall desired.



## CHAP. IX.

*Distance of Latitude and distance Meridionall,  
given to find the Rhombe.*



Ayling from the North Paralell 69 degrees 20 min. untill the Pole be depressed foure degrees and 9 min. and the distance Meridionall, or difference of Longitude, six degrees to finde the Rhombe is required. By the first Demonstration, draw the Quadrant A K C B, then turne your four degrees nine minutes into Leagues, it maketh eighty three Leagues; which place upon the line A K F, from A, unto E, then subtract the difference of the two Latitudes, from the number of the first Latitude, and it leaves the second Latitude 62 deg. 11 min. Then opening the Compasses unto the middle Latitude, which is sixty four degrees, and fifteen minntes of the Cord, applying it unto the first Line of Longitudes, and you shall finde eight Leagues, two miles, and four seconds to answere unto one degree: then set your Compasses in one degree, in your second Line of Longitudes, and extend the other foote unto eight Leagues, and two miles, and four seconds: then with that distance of the Compasses, place the one foot at six degrees of that line, and turne the other upward, and it will extend unto fifty six leagues, therefore open your Compasses to the distance of fifty six Leagues, in the line of equall leagues, and apply them from the point P, upon the line F D, parallell unto A B, from F, unto D, then from the point D, draw the line



line D A cutting the Quadrant K C B, in C, so shall K C, be the distance of the Rhombe from the South Westward, which is just thirty three degrees, forty five minutes from the South, which is Southwest and by South, the Rhombe desired.

CHAP. X.

*By the Latitude of two places, and distance upon the Rhombe to finde the leagues sailed.*

*The Pole depressed three degrees thirty minutes, the Rhombe the fourth from the Meridian.*



**I**N the second Demonstration draw the line A E, then from A, raise the Perpendicular A C, then opening the Compasses to the distance of the Radius, placing one foot thereof in the Centre A, and with the other draw the Quadrant B D E. Then reduce your three degrees, thirty minutes into leagues, counting for every degree, twentie Leagues, and for thirty minutes ten Leagues, so they make seventy Leagues; then open your Compasses unto seventy degrees in the line of equall parts, and place them upon the line A B C, from A, unto C, then from C, draw the line C F, Parallell unto A E. Then in regard your Rhombe was the fourth from the South, take foure of the eight points of the Compasse, and place them upon  
the

the Quadrant from B, unto D, then from A, by the point D, draw the line A D F, cutting the line C F, in F. So shall the distance betwixt A, and F, bee the number of leagues (upon the fourth Rhombe) before you can either raise or depreſſe the Pole three degrees thirty minutes, which is here found to be ninety nine Leagues.

## CHAP. XI,

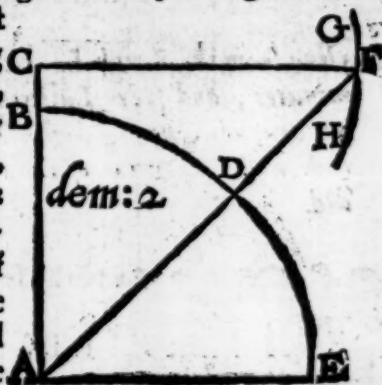
*To find the distance of any Island from you that you may diſcerne by two Stations, knowing the point of the Compaſſe, the Iſland beareth unto each of the Stations.*

*Suppoſe (being at Sea) you diſcover an Iſland bearing South-weſt of you, which place let it be your firſt Station, and ſeventy Leagues ſailing South obſerving the Iſland to beare Weſt of you, which let be the ſecond Station, the demnod is to finde the Iſland from both the Stations.*



**I**N the ſecond Demonſtration let A, be the firſt Station, and upon the Centre A, draw the quadrant ABDE, then in regard you found the Iſland to beare South weſt from you, therefore take four of your eight points of Compaſſe, and place them upon your Quarant from E, unto D, then from the Centre A, by

by the point D, draw the line ADF. representing the visuall Line passing betwixt your sight and the Island, being in the first Station. Then sayling C seventy leagues South, which is from A, your first Station, unto C, the second Station: then observing the Island to beare West of you, therefore from the point C, the second Station, draw the Line



CF, parallell unto AE, cutting the Line ADE, in point F, so shall the point F, be the place of the Island desired, and the distance AF, is the distance of the Island from the first Station, which is just ninety nine Leagues off the Line of equall parts. And likewise the distance from C, unto F, is the distance of the Island from the second Station, which is here found to be just seventy Leagues: and by this manner of work you may finde the distance of any Island from you, which you may discern either by Sea or Land.

D

CHAP.

## CHAP. XII.

*Sayling from the South Longitude of 60 degrees, 51 minutes, and from Latitude 25 degrees, 24 min. 99 Leagues, upon a South-west course: the Latitude and Longitude of the second place is demanded.*



In the second Demonstration, draw the Quadrant A B C D E, as is formerly taught: then in regard you sail South-west, take four points of the Compass from your Scale, & place them from B, unto D, then by the point D draw the line A D E, then place your ninety nine Leagues upon the Line A D E, from A, unto F, so shall E be the place of your ship. Then from F, draw the Line F G, parallel unto A E, cutting the line A B C, in C, so let the distance C A be Leagues that you have run South, which is 70 Leagues, or 3 deg. 30 min. which being added to the Latitude from whence you departed, makes sixty four degrees, and twenty one minutes for the Latitude of the second place: then take the distance C F, and apply it unto the Line of equal parts, and you shall find it likewise seventy Leagues: then opening your Compasses unto the middle Latitude 62 degrees, 36 minutes in the Line of Cordes, and apply it unto the first Line of Longitudes, you shall finde that nine leagues and 0 miles, and 38 seconds, doe alter a degree of longitude, then placing one foot of your Compasses in the second line of longitudes,

gitudes, at 9 leagues and thirty eight seconds, and extend the other to one, then keeping the distance of the Compasses, set one foot in the seventy leagues of the same line, and the other foot will extend unto 7 d grees 37 min. which being subtracted from the longitude from whence you departed, leaves seventeen degrees, and forty seven minutes for the Longitude of the second Place.

CHAP. XIII.

*A Ship sayling from the North Parallell of fifty degrees, having an hundred Leagues to saile South-west, and by west, by the way is inforced by contrary windes, to saile upon severall points of the Compass, first sayling thirty leagues upon a direct course, then west North-west twenty Leagues, then South sixty Leagues, the question is to find the Latitude of the second place, how farre it is to the place wherunto you are bound, the distance of the Rhombe that is betwixt them, the distance that you are from your first Meridian, and thereby the difference of Longitude.*



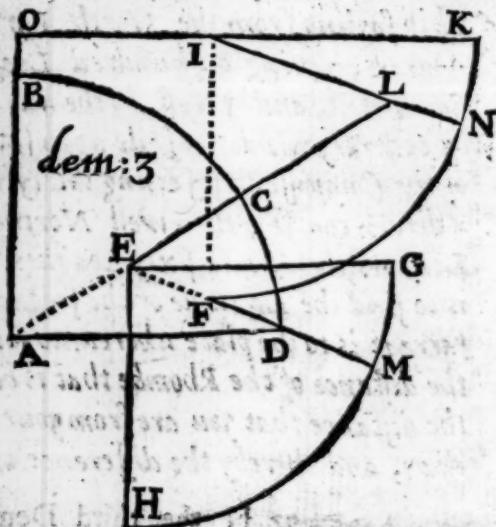
**N** the third Demonstration, draw the Line A D, and from the point A, raise the perpendicular A B, then open your Compasses unto the Radius of your Scale, and place one foot thereof in the centre A, and with the other draw the Quadrant B C D, then take three points of the Compasses, and  
D 2 place



and place them upon the Quadrant from D, unto C, then from the Centre A, by the point E, draw the line A C L, 100 Leagues in length, which is the true course you are to saile. Then in regard you sayled 30 leagues direct, take thirty degrees from your Scale of equall parts, and place them upon the line A E C, extending from A, unto E, then in regard you turned your Course, West, Northwest, from the Centre E, draw the Line E G, parallell unto A D, and againe from the Centre E, draw the Line E H, Perpendicular to E G, and parallell to A B, then with the distance of the Ra- O

of the Radius, set one foot of your compasses in the Centre E, and with the other draw the quadrant G M H, and in regard you sayled west, Northwest, which is 2 points from the West.

Northward, take from your Scale two points of the Compasses, and place them upon the Quadrant G M, H, from G, unto M, then from the Centre E, unto the point M, draw the line E F M, then take twenty leagues with your Compasses from the Scale of equal parts, and place them upon the line E F M, from E, unto F, then is your Ship in the point F. Lastly, in re-  
gard





gard you run South sixty Leagues, from F, draw a Line Parallell unto the Meridian A B, which is the line F I, then take from your Scale of equall parts 60 Leagues, and place them from F, unto I, then is your Ship in the point I, then last of all is to be found how far it is to the place whereunto you were bound, the distance of the Rhombe that is betwixt you, the degrees and minutes you have raised the Pole, the distance of departure from the first Meridian, and thereby the difference of Longitude, and that you may so doe, first draw the line O I K. Perpendicular unto the line I F, in the point I, and with your Compasses opened unto the distance of the Radius, set one foot of your Compasses in the Centre I, and with the other draw the Quadrant K N F, then in regard your ship is in the point I, and the place whereunto you are bound in the point L, therefore from I, thorow the point L, draw the Line I L N, cutting the Arch K N F, in the point N, therefore let I L, be the Leagues you have unto the place whereunto you are bound, which is forty one Leagues and a halfe, and the Rhombé the distance K N, which is West, and by North, and three degrees unto the Northward, so likewise is the line A O, the number of Leagues you have run due South, which is 68 Leagues; and one Mile, or 3 degrees and 25 minuts, which being taken from 50 degrees, the parallell from which you departed, leaves 46 degrees and 35 minutes for the Parallell you are in. Last of all, shall the line I O, be the Leagues that you have departed your first Meridian, which are 41 leagues and one mile: then open your Compasses unto 48 degrees 17 minuts and 30 seconds of the line of Cords, which is the middle Latitude, and apply it unto the first line of Longitudes, you shall finde that

13 Leagues, or miles, fifty six seconds do answer unto a degree of Longitude in that Parallel, then setting one foot of your Compasses in 13 Leagues, and 56 seconds in your second line of Longitudes, extending the other unto one degree, then with the same distance of your Compasses, set one foot in 42 Leagues and one mile of the same line, and the other will shew you 3 degrees and 13 minutes, which is the difference of the Longitude desired.

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CHAP. IV.

*Two Ships departing from one Parallel, and Port; the one in sailing eight Leagues betwixt the North, and the West, hath raised the Pole two degrees, the other in sailing a hundred Leagues betwixt the North, and West, hath raised the Pole foure degrees, I demand by what Rhombes the said Ships have saild, and the Rhombe, and distance that is betwixt them.*



**I**N the fourth Demonstration, draw the Quadrant A B C D E, then in regard the first Shippe hath raised the Pole two degrees, which is forty leagues, take forty leagues of your Scale, and apply them unto the Meridian line A G L, from A, unto G, then from the point G, draw the line G F, parallel unto A B, then opening your compasses unto 80 Leagues set one foot in the Centre A, with

with the other, make a marke in the line *GF*, which will be at *F*, so shall *F*, bee the place of the first shippe: the second shippe hath rayled the Pole four degrees, which is eighty Leagues, therefore place eighty Leagues upon the Meridian line *AGL*, from *A*. unto *L*, and from the point *L*, draw the line *LM*, parallell unto *GHF*, then open your Compasses unto the distance of an hundred Leagues, which are the Leagues the second ship did runne, and set the foot of your Compasses in the Centre *A*, & with the other make a marke in the Line *LM*, which will be at *M*, then draw the line *MA* which is the course of the second Ship, and the line *FA*, is the course of the first ship, then from *F* let a Perpendicular fall, being Perpendicular to the Line *GF*, which is the line *FK*, then opening your Compasses unto the Radius of your Scale, set one foot in the Centre *F*, and with the other draw the Quadrant *HIK*, likewise from *F*, the place of the first ship, draw a line by the point *M*, the place of the second ship: cutting the quadrant *KHI*, in *I*, so let *IK*, be the course that is betwixt them, that is, if you will saile from the first ship unto the second, you must saile North, and by East, & 41 minutes to the Eastward, likewise let *FM*, be the distance that is betwixt them, which in this Demonstration is 40 Leagues, two miles, so shall *BC*, be the course of the first shippe from the West Northward, which here is found to be 30 degrees and one minute from the West Northward, or North west, by West & 3 deg. and 44 min. to the westward. Lastly, the Arch *ED*, is in the distance of the course that the second ship made from the North Westward, which is found by this Demonstration to be Northwest, and by North, and three degrees five minutes to the Westward.

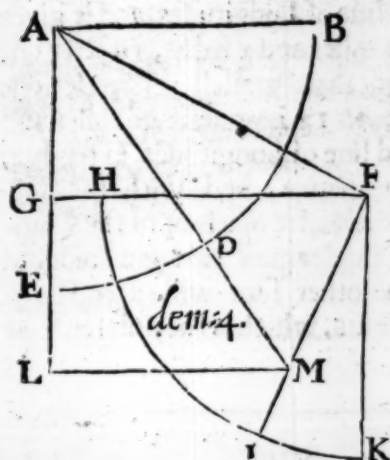
C H A P.

## CHAP. XV.

*Two Ships departing from one Parallell and Port, in the Parallell of 47 degrees 56 minutes, the first in sayling 80 Leagues betwixt the North and West, hath raised the Pole two degrees, I demand by what course the second ship must run, and how much shee shall alter in her first Meridian or Longitude, to bring her selfe 40 Leagues and two Miles North and by East, and forty one Minutes to the Eastward of the first ship.*



**N** the fourth Demonstration draw the Quadrant A B C D E, then multiply your two degrees, you have altered your latitude by twenty, and it maketh forty Leagues; which forty Leagues set upon the line A E L, from A, unto G, then from the point G, draw the line G F, Parallell unto A B, then open your Compasses unto the distance of 80 Leagues, which are the Leagues your first ship did run, and place one foot of your Compasses in the Centre A, and with the other make a marke in the Line G F, which will be at the point F, then from the Centre A, unto the point F, draw the line A F, representing the distance of the course of the first ship 80 Leagues; Then from F, let fall a perpendicular F K, and upon the Centre F, upon the Radices of the Scale draw the Arch H I K. Then in regard you must bring the second shippe North



North and by East,  
and 41 minuts East-  
ward of the first  
ship, take 11 de-  
grees, 56 minutes  
from your Scale of  
Coards, and place  
them from K, unto  
I upon the Qua-  
drant K I H, Then  
from F, draw the  
line I F, and upon  
the line F I, place the  
distance that you  
must bring the se-  
cond ship from the

first ( which is 40 leagues and two miles ) from F,  
unto M, So is M, the place of your second ship. Then  
from M, draw the line M L, parallell unto F G, cut-  
ting the line A G L, in L, then draw the line M A,  
cutting the Quadrant B D E, in D. So shall the arch  
D E, be the course that the second ship must run, to  
bring her selfe 40 leagues, and two miles North and  
by East, and 41 minuts East of the first ship. Then  
to know what you have altered the Latitude, first take  
the distance L A, and apply it unto the Scale of e-  
quall parts, and you shall finde it to be 80 leagues,  
which is just 4 degrees, which you have altered your  
latitude, or Poles elevation: which 4 degrees added  
unto the Latitude you departed from it, makes 51  
degrees, 56 minutes for the Latitude that your se-  
cond ship is in, then take the distance L M, and ap-  
ply it to the Scale, it gives 60 leagues; then open your  
Compasses unto the distance of the middle Latitude;

E

which



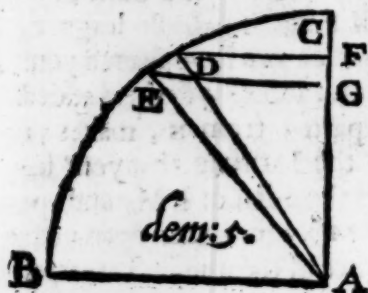
which is 39 degrees, 51 minutes of the Coard, and apply it unto the first line of Longitudes, and it gives 12 Leagues, and two miles and a halfe, to alter one degree of Longitude in that Parallell: Then set one foot of your Compasses in 12 Leagues, two miles and an halfe in the second line of Longitudes, extending the other foot unto one degree, and with the same distance upon the same Line, set one foot of the Compasses in 60 leagues (the leagues that you are from the Meridian) and the other foot will extend unto foure degrees forty minuts, which is the difference of the Longitude.

## CHAP. XVI.

*To finde by Demonstration how many miles or minutes of any Parallell, doth answer unto one degree of the Equinoctiall.*



Et the Latitude given be 58 degrees 54 minuts, therefore having drawne the Quadrant A B C, from B, upon the Coard B E C, set the Latitude of the place 58 degrees 54 minuts unto the point D. Then from the Point



D, draw the line D F, parallell unto B A. So shall the length of the line D F, be the number of miles which answer unto one degree of Longitude in the parallell of 58 degrees 54 minuts, which being  
ap



applied unto your Scale of equall parts, gives thirty one miles. So likewise the Arke B E, being the Latitude of 52 degrees, ending in the point E, give the lines E G. For the miles that answer unto one Degree of Longitude in the parallell of 52 Degrees, were found by the Scale to be thirty six miles, and 56 seconds, or  $\frac{1}{4}$  of a mile.

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THE

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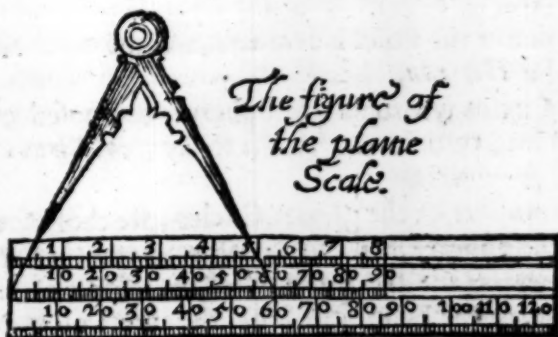
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THE SECOND BOOK OF  
THE PLAINSCALE, WHEREIN

is declared the definition of the Sphear, a description  
of the six great Circles, and also of the foure lesser  
Circles, and last of all certaine Questions  
Astronomicall, performed by  
the said Scale.

CHAP. I,

De Spheara.



Spheare according to the de-  
scription of Theodosius, is a cer-  
taine solid Superficies, in whose  
middle is a Point, from which  
all lines drawne unto the Cir-  
cumference are equall; which  
Point is called the Centre of  
the Sphear, by which Centre a  
right Line being drawn, & extending himselfe on ei-

E 3

ther

ther side unto that part of the Circumference whereupon the Sphear is turned, is called *Axis Spæra*, or the Axletree of the World.

A Sphear accidentally is divided into two parts, that is to say, in *Sphæram rectam*, & *Sphæram obliquam*.

*Sphæra recta*, or a right Sphear, is onely unto those that dwell under the *Equinoctiall*, *Quibus neuter Polorum magis altero elevatur*: that is, to whom neither of the Poles of the World are seen, that lie hid in the *Horizon*.

*Sphæra obliqua*, or an oblique Sphear, is unto those that inhabit on either side of the *Equinoctiall*, unto whom one of the Poles is ever seen, and the other hid under the *Horizon*.

The Circles wherupon the Sphear is composed are divided into two sorts: that is to say, in *Circulos majores & minores*.

*Circuli majores*, or the greater Circles, are those that divide the Spheare into two equall parts and they are in number six: viz. the *Equinoctiall*, the middle of the Sodiacke, or the Ecliptique Line, the two Coloures, the *Meridian* and the *Horizon*,

*Minores vero Circuli*, or the lesser Circles, are such as divide the Sphear into two parts, unequally: and they are four in number; as the Tropick of *Cancer*, the Tropick of *Capricorn*: the Circle *Arcticke*, and the Circle *Antarcticke*.

CHAP.

CHAP. II.  
Of the four greater Circles.

**T**He *Equinoctiall* is a Circle that croseth the Poles of the World at right angles, and divideth the Sphear into two equall parts, and is called the *Equinoctiall*, because when the Sunne cometh unto it, which is twice in the year, *viz. In Principio Arietis, & Libra*, that is, *March* and *September*) the dayes and nights are equall throughout the whole World, whereupon it is called, *Equator diei & noctis*, the equall proportioner of the day and night artificiall; and in the figure is described by the Line CAE.

The *Meridian* is a great Circle, passing thorow the Poles of the World, and the Poles of the *Horizon*, or *Zenith* point over our heads, and is so called, because that in any time of the yeare, or in any place of the World, when the Sunne (by the motion of the Heavens) cometh unto that Circle, it is noone or 12 of the Clock. And it is to be understood, that all townes and places that lie East and West one of another, have every one a severall Meridian: but all places that lie North and South one of another, have one and the same Meridian. This Circle is declared in the figure following by the Circle B C D E.

The *Horizon* is a Circle, dividing the superiour *Hemisphere* from the inferiour, whetupon it is called *Horizon*. that is to say, the bonds of sight, or the farthest distance that the eye can see, and therefore it is also called *Circulus Hemisphere*. The *Horizons* are divided into two sorts, *viz. Rectus & obliquus*, a right  
and



and an oblique, or a declining *Horizon*: whereof those have a right *Horizon* which have the *Equinoctiall* for their *Zenith*, and the Poles of the World in their *Horizon*: Because the *Horizon* (hiding both the Poles of the World) is a Circle supposed to be drawne by the Poles of the World, dividing the *Equinoctiall* at right angles, as in the figure following you may plainly see. First, imagining the Circle X V Y W, to be the earth, and those that inhabit at the Point V, have the line B D, for their *Horizon*, cutting the *Equinoctiall* C A E, at right angles in A, and therefore is called *Horizon rectus & Sphaerella*, a right *Horizon*, and a right *Sphaere*. Those have an oblique *Sphaere*, or an oblique *Horizon* to whom one of the Poles are visuell, or elevated above the *Horizon*, and have the other hid under the *Horizon*, and in regard such a *Horizon* doth crosse the *Equinoctiall* at oblique angles, it is called *Horizon obliquus*, or a declining *Horizon*, as for example: Those that inhabit at the point S, have T, for their *Zenith* and K A L, for their *Horizon*, dividing the *Equinoctiall* C A E, at oblique angles, making the angle contained betwixt the *Horizon* A K, and the *Equinoctiall* A C, an angle of thirty eight degrees, and 28 minutes, and the angle contained betwixt the *Horizon* A L, and the Pole A D, an angle of 51 deg. 32 minuts, which is the elevation of the Pole for those that inhabit at S, those and all other have an oblique *Sphaere*, except they inhabit just under the *Equinoctiall* Circle, unto whom onely doth a right *Sphaere* belong.

*Columna Solstitiorum*, or the Summer Colure is a Circle passing by the Poles of the World, and by the Poles of the Ecliptique, and by the head of *Cancer*,  
and

and *Capricorn*, whereupon the first scruple of *Cancer* where the Colure crosseth the Ecliptique Line, is called *Punctus Solstitii aestivalis*, or the point of the Summer Solstice: to which place when the Sun cometh he can approach no neerer unto our *Zenith*, but returneth unto the *Equator* again. *Arcus vero Colari*. The Arke of the Colure contained betwixt the Summer Solstice and the *Equator*, is called the greatest declination of the Sun, which *Ptolemy* found to be 23 degrees, 31 minutes: but by the observation of *Copernicus* it was found to vary, for he found the declination sometimes to be 23 degrees 52, minutes, and in the process of time, to bee but 23 degrees, 28 minutes. And in these our dayes (by the observation of *Ticho de Brabe*, and that late famous Mathematician, Master *Edward Right*) it is found distant from the *Equinoctiall* 23 degrees 31 minutes 30 seconds.

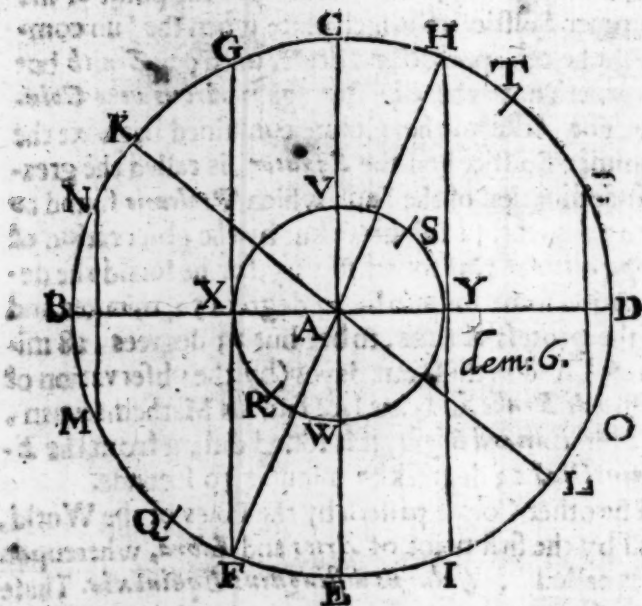
The other Colure passeth by the Poles of the World, and by the first point of *Aries* and *Libra*, whereupon it is called, *Colurus distinguens Equinoxia*. These two Colures doe crosse each other at right angles, in the Poles of the world, whereupon these Verics were made:

*Hæc duo Solstitia faciunt Cancer, Capricornus;  
Sed noctes æquant Aries & Libra diebus,*

The *Zodiack* is another of the greater Circles, dividing the *Equinoctiall* into two equall parts, by the head of *Aries* and *Libra*, the one halfe of it doth decline unto the North, the other into the South, the greatest of which declination, is 23 degrees, 31 minutes, and 30 seconds. Note also, this Circle is divided into 12 equall parts, which parts, are attributed

F

unto



unto the 12 Signe, *Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricornus, Aquarius, & Pisces*. And every one of these Signes are divided into 30 equal parts, which are called degrees, so the whole Zodiack containeth 160 degrees. Likewise every degree is divided into 60 equal parts, which parts are called minutes, and are in number 1600 minutes, and as 1600 minutes is the whole circumference of the Heavens, so is 1600 miles the whole circuit of the Earth.

## CHAP. III.

## Of the four lesser Circles.



He Sun having ascended unto his highest Solstitiall Point doth describe a Circle, which is the neereſt that he can approach unto the North Pole, whereupon it is called, *Circulus Solſtitii æſtivalis*, the Circle of the Summer Solſtice, or the Tropick of *Cancer*, and is noted in the figure before, by the line H. Y. I.

The Sun alſo approaching unto the firſt ſample of *Capricornus*, or the Winter Solſtice, deſcribeth another Circle, which is the utmoſt bounds that the Sun can depart from the Equinoctiall Line towards the Antartike Pole, whereupon it is called, *Circulus Solſtitii hyemalis, ſive Tropicus hyemalis, vel Capricorni*: the Circle of the Winter Solſtice, the Winter Tropick, or the Tropick of *Capricorn*, and is deſcribed in the figure by the Line G. X. F.

So much as the Ecliptick declineth from the Equinoctiall, ſo much doth the Poles of the Ecliptick decline from the Poles of the World, whereupon the Pole of the Ecliptick, which is by the North Pole of the World, deſcribeth a certain circle as it paſſeth about the Pole of the World, being juſt ſo farre from the Pole as the Tropick of *Cancer*, is from the Equator, and it is the third of the leſſer Circles, and is called, *Circulus Arcticus*, or the Circle of the North Pole, and is deſcribed in the *Diagram*, in the ſecond Chapter by the Line P. Q.

The fourth and laſt of the leſſer Circles, is deſcribed in like manner, by the other Pole of the Ecliptick about the South Pole of the World, and therefore

called *Circulus Antarticus*, the Antartick Circle, or the Circle of the Antartick or South Pole, and is demonstrated in the former figure, by the line N.M.

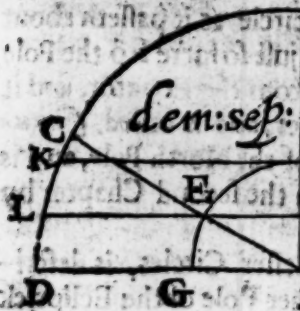
*Certain questions Astronomicall performed by  
the plaine SCALE.*

CHAP. IV.

*The true place of the Sun, given to finde  
his declination.*



He Sun being in the head of *Taurus*, his declination is desired: by the seventh Demonstration, draw the line A.D. then upon the Centre A. raise the Perpendicular A.B. then opening your Compasses to the Radius of your Scale, and place one foot in the Centre A. and with the other draw the Quadrant B.C.D. then opening your Compasses unto the greatest declination of the Sun, and place it upon the Quadrant from D unto K. then from the point K. draw the Line K.H. cutting the line A. B. in



H. then with the distance A. H. draw the small Quadrant G. E. H. and in regard the Sun is in the head of *Taurus*, which is thirty degrees from the beginning of *Aries*, let A. D. be the Equator, and



and D the beginning of *Aries*, D. C. 30 degrees, or Longitude of the Sunne, then from the point C. draw the line C. A. cutting the Quadrant G. E. H. in B then from E. draw the line E. L. parallell to A. D. cutting the Quadrant B. C. D. in L. So shall the arch L. D. be the declination of the Sun desired, which in this demonstration is found to be 11 deg. and 31 minutes.

CHAP. V.

*The declination of the Sun, and quarter of the Eclipse that he possesseth being given, it is desired to finde his true place.*

*The declination is 10 degrees 31 minutes, the first quarter that he possesseth, is betwixt the head of Aries and Cancer.*

**F**irst by the seventh Demonstration draw the Quadrant A. B. C. D. as is taught in the former Chapter, then set the greatest declination of the Sun upon the Cord from D. unto K. which is 23 deg. and 31 minutes, then from K. draw the line K. H. parallell unto the Equator D. A. cutting the line B. A. in the point H. So shall H. A. be the signe of the Suns greatest declination, then with the distance A. H. draw the Circle, G. E. H. then from D. upon the Cord D. B. C. set the declination of the Sun which is 11 degrees, 31 min. from D. unto L. then draw the line L. E. parallell unto A. D. cutting the Quadrant G. E. H. in E. Then from the Centre A: by the point E. draw the line A. E. C. cutting the Quadrant B. C. D. in C. So shall the arke

**C.** D. be the distance of the Sunne from the head of *Aries*, which is here found to be just 30 deg. which is in the beginning of *Taurus*.

# CHAP. VI.

*By the elevation of the Pole, and declination of the Sun, to finde the amplitude of the Sun, or his true rising, or setting from the East or West point.*

**B**Y the eight Demonstration, first draw the line B. D. then upon the Centre A. draw the Circle B. C. D. E then from A. rise the perpendicular C. A. E. then is your Circle divided into foure equal parts: then suppose the elevation of the Pole to be 51 deg. 32 min. which must be placed upon the Circle, from D. unto F. then from the point F. by the Centre A. draw the line F. A. G. representing the Pole of the World F. being the North Pole, and G. the South Pole, then subtract, 51 deg. 32 min. from 90 deg. and the remainder is the height of the Equinoctiall, which is 38 deg. 28 min. which must be placed upon the Circle from the Horizon B. unto the point I: then from I. by the Centre A. draw the line I. A. H. representing the Equinoctiall Circle. Then from I. unto M. set the declination of the Sun, being here supposed 14 deg. 52 min. North, then from the point M. draw the line, or parallell of declination M. I. N. parallell into the Equinoctiall A. H. cutting the Horizon B. D. in T. then from T. rise the perpendicular T. V. cutting the Circle B. C. D. E. in V. so shall the distance C. V. be the true amplitude of the Sunne desired, which here is found to be 24 deg. 21 min. North.

CHAP.

## CHAP. VII.

*By the Amplitude of the Sun to find the  
Variation of the Compass.*

**H**AVING found the amplitude of the Sun by the last Chapter, first observe with a Compasse, rather with a Semicircle upon what degree and minute the Sun riseth or setteth, beginning to reckon from the East or West, & ending at the North or South at 90 degrees: and when you have diligently observed the Magneticall rising or setting, by the Semicircle, or by some other like fitting instrument: and also the true amplitude found, as is declared in the last Chapter, the difference of these two amplitudes, is the variation of the Compass: But when the sunne riseth upon the same degree of the Compasse, as is found by the Scale, the variation is nothing, but the needle pointeth directly unto the Poles of the World, which by Master *Mulinus* was affirmed to be at the Westernmost part of *Saint Michaels*, one of the Islands of the *Azores*, from whence hee will have the Longitude reckoned. Secondly when the Sunne is in the *Equinoctiall* Circle, where hee hath no amplitude, looke what distance the Compasse maketh the Sun to rise from the East or West of the Compasse, the same distance is the Compasses variation, from the North or South. Thirdly, if the Sun rise more to the South of the Compasse, or setteth more to the North by the compasse, then is shewed by the Scale, the difference betwixt the amplitude given by the Scale, and the ampli-

amplitude given by the Needle, is the Variation of the Compass from the North Westward. Fourthly; If the Compass sheweth the Sun to rise more Northward, or set more Southward, then is shewed by the Scale, the difference is the variation of the Compass, from the North Eastward. Fifthly, if the Scale shew the amplitude of the Sunne rising Southerly; and the Compass shew it to bee Northerly, adde both the Amplitudes together, and they shew you the variation Westerly.

# CHAP. VIII.

*The place of the Sun being given to find his Declination by a whole Circle.*



According unto the right Demonstration, first draw the Circle B.C.D. E. then draw the Horizon B. A. D. and then the *Equinoctial* I. A. H. as is before taught: and then the Tropicke of *Cancer* K. L. 23 degrees and a halfe from the *Equinoctial*; then draw the Tropicke of *Capricorn* P. O. of like distance from the *Equinoctial*, and after from K to O. draw the *Ecliptique* Line K. A. O. And when you have thus laid down the Spheare, suppose the Sun to be in the tenth degree of *Taurus*, at which time his declination is desired. And in regard the Sunne is more neere unto the Tropicall point *Cancer*, then unto *Capricorn*; first finde how many

many degrees hee is from the Tropick of *Cancer*, and you shall finde him to bee 50 degrees; therefore take with your Compasses 50 degrees from the Coard, and apply it from the Tropicall point *Cancer*, at K unto V. upon one side, and upon P. on the other side: then draw the Line V. P. cutting the Ecliptick K, O. in the point R. then from R. draw the Line M, R N. parallel unto the Equinoctiall I. A. H. and cutting the Quadrant B. C. in the point M. So shall the Arke M. I. be the declination of the Sun desired, which being applied unto your Scale, gives you 14 degrees and 53 minutes.

CHAP. IX.

*The elevation of the Pole, and declination of the Sun, given to finde his height in the verticall Circle.*

*The Pole, is elevated 51 deg. 32 minutes, the declination of the Sun is 14 degrees 53 minutes North, his height in the verticall Circle is found as followeth.*



First according unto the former Chapter draw the Circle B. C. D. E then the Horizon B. A. D. and after the Verticall Line C. A. E. then the Pole of the World F. G. and likewise the Equator I. A. H. this being don, place the declination of the Sun 14 degrees, 53 minutes, upon the Circle from I. unto M. and also from H. unto N. then draw the Line M. N. cutting the line

G

G

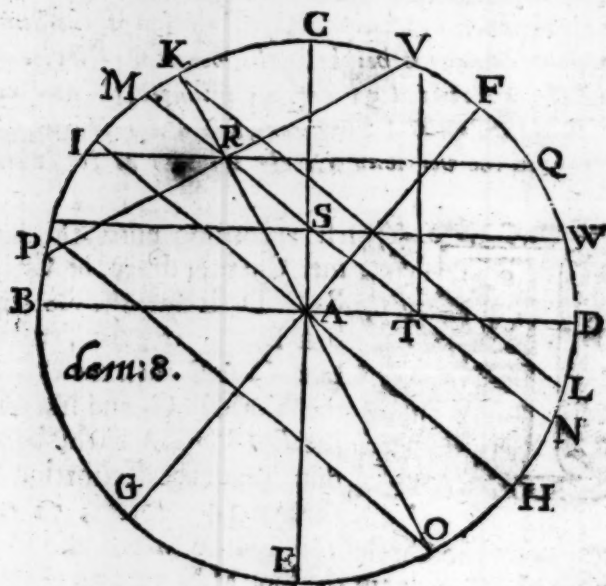


C.A.E. in S then from S, Draw the Line S.W. Parallel unto the Horizon B.A.D. cutting the Meridian Circle B.C.D.E. in W. So shall the distance D.W. be the height of the Sun in the verticle Circle for the time demanded which by this proposition is found to be 19 degrees and 8 minutes.

## CHAP. X.

*The elevation of the Pole, and the Amplitude of the Sun, being given, to finde the declination.*

*The elevation of the Pole is 51 deg. 32 min, the Sunns Amplitude is 24 deg. 21 minutes, the declination is found as followeth by the eight Demonstration.*



First,



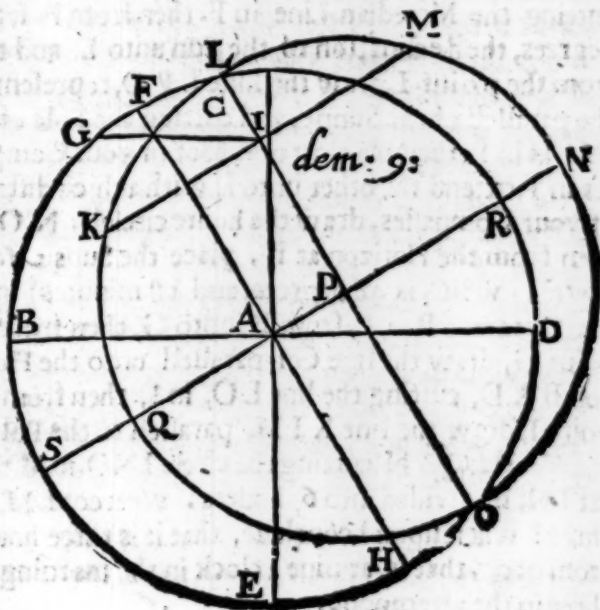
First upon the Center A. draw the Circle B. C. D. E. then draw the Line B. A. D. representing the Horizon, dividing the Circle into two equall parts: then draw the Line C A E, perpendicular to B A D. representing the East & West point of the Compass, then placing the elevation of the Pole 51 degrees, and 32 minutes, from D unto F. from F, by the Centre A, draw the Line F A G, which let be the Pole or Axel-tree of the World; then from B unto I, and from D unto H, set the complement of the Poles elevation: which shall represent the Equinoctiall, in regard it maketh right angles with the Pole of the World, in the Centre A. Then from C unto V. place the amplitude of the Sun, which is 24 degrees, and 21 minutes: then from V, let fall the perpendicular V T, cutting the Horizon B A D, in the point T: then from the point T, draw the Line M T N, parallell unto the Equinoctiall I A H: and cutting the Circle BCDE, in the point M and N, so let the distance of I and M, or H and N, be the declination of the Sun, which was desired: which being applied unto your Scale, gives you 14 degrees, and 52 minutes.

*The elevation of the Pole, the declination of the Sunne, and houre of the day, being given to finde the Almicanter is desired.*

*The elevation of the Pole is 30 degrees, the declination of the Sun is 20 degrees North, the houre is nine in the morning, at which time the Almicanter is found, as followeth.*

**B**Y the ninth Demonſtration, firſt upon the Centre A, draw the circle B C D E, then draw the Line B. D. for the Horizon, then place your Poles elevation which is 30 degrees upon the circle from D, unto R, then from R by the Centre A, draw the line R A S, representing the Pole of the World, then from B unto F, place the Complement of the Poles elevation, which is 60. degrees, and from the point F, by the Centre A, draw the line F A H, representing the Equinoctiall Line, and then ſet the declination of the Sun from F, unto L, and from L, draw the Line L P O, parallel unto the *Equator* F A H, cutting the Pole of the World in the point P, then ſet one foot of your Compaſſes in the point P, and extend the other either unto L, or unto O, and with the ſame diſtance of your Compaſſes, upon the centre P, draw the circle L N O Q, which is called the houre circle, ſo ſhall L, be the point of 12 a clock at noone, N, the place of ſix a clock afternoone, O the place of 12 a clock at midnight, and Q the place of ſix a clock in the morning: Every one of the foure quarters, muſt be

be divided into six equall parts, or houres, making the whole Circle to containe 24 parts, representing the 24 houres of the day and night, then in regard the houre of the day was 9 of the clock, which is 3 houres forenoone, take three of these 24 houres, and place them upon the Circle LNOQ, from the Meridian point L, unto K, the nine a clock point in the morning, and unto M, the point of three a clock after noon, then draw the line MK, cutting the parallell of the Sun LO, in the point I, then from I, draw the line IG, parallell unto the Horizon BAD, which shall cut the Meridian Circle BCDE, in the point G, so let the distance of G and B be the Almicanter of the Sun which was desired, which in this Demonstration is found to be 48 degrees and 18 minutes.



CHAP

## CHAP. XII.

The elevation of the Pole, the Almicanter, and declination of the Sun, being given to finde the hours of the day.

The elevation of the Pole is 30 degrees, the declination of the Sun is 20 degrees, the Almicanter of the Sun is 48 degrees, and 18 minutes, the hours of the day is found as fo loweth, by the ninth Demonstration.



1<sup>st</sup>, upon the centre A, draw the Circle B. C. D. E. then draw the Diameter B. D. representing the Horizon, then from D. unto R. set 30 degrees, the elevation of the Pole, then from R. by the Point A, draw the line R. A. S. representing the Pole of the World, then draw the line F. A. H. crossing the Pole in A. at right Angles, cutting the Meridian Line in F. then from F. set 20 degrees, the declination of the Sun unto L. and then from the point L, draw the Line L P O, representing the parallell of the Sunne, and cutting the Pole of the World in P, then placing one foot of your Compasses in P, extend the other unto L, with which distance of your Compasses, draw the houre circle I, N O Q. then from the Horizon at B, place the Suns Almicanter: (which is 48 degrees, and 18 minutes) upon the Quadrant B G L, from B, unto G, then from the point G, draw the line G I, parallell unto the Horizon B A D, cutting the line L O, in I, then from the point I, draw the line K I M, parallell to the Pole of the World Q A N, cutting the circle I N O, in M, then let I N, be divided into 6 houres, whereof L M, are three: whereupon I conclude, that it is three houres from noon, that is, at nine a clock in the morning, or three in the afternoon.

CHAP.



## CHAP. XIII.

*The Almicanter, or height of the Sun being given,  
to finde the length of the right shadow.*



According unto the tenth Diagram, draw the Line *AE*, and upon the Centre *A*, raise the Perpendicular *AC*; then upon the Centre *A*, draw the Quadrant *CDE*, then suppose the height of your *Gnomon*, or substance yielding shadow be the Line *AB*, which is to be divided into 12 equall parts, which *Gnomon* I have heere made just 12 degrees of the equall League of the Scale: then from *B* to the top of the *Gnomon*, draw the Line *BE*, Parallell unto *AF*. then set the *Almicanter* which is 45 degrees from *B* unto *D*, and from the point *D*, draw the Line *DA*, cutting the Line *BE*, in the point *G*, so shall *BG* be the length of the right shadow desired, which is heere found to be 14 degrees and 18 minutes, which is but just the length of your *Gnomon*, and  $\frac{3}{4}$ , and  $\frac{1}{4}$  of a twelfth over: Note that the right shadow, is the shadow of any Post, Staffe, or Steeple, that standeth at right angles with the Horizon, the one end thereof respecting the Zenith of the place, and the other the *Nadir*.

CHAP.



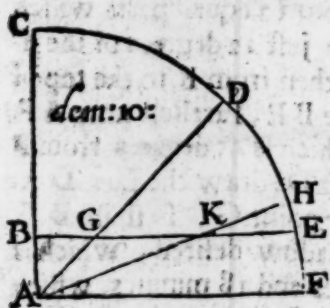
## CHAP. XIV.

The Almicanter, or height of the Sun being given to find the length of the contrary shadow.



Y the verse or contrary shadow, is understood the length of any shadow, that is made by a Staffe or *Gnomon* standing against any perpendicular wall, in such a manner that it may lie parallell unto the Horizon, the length of the contrary shadow, doth increase as

the Sunne riseth in height : whereas contrariwise the right shadow doth decrease in length, as the Sun doth increase in height : the way to find the verse shadow, is as followeth. First, draw your Quadrant as is taught in the last Chapter wherein let A B, be the length of the



*Gnomon*, likewise from B, draw the line BE, parallell unto A. F, as before, then set your *Almicanter* from C, upon the Quadrant which is given to be 70 degrees, and it will extend from C, unto H, then from the point H, draw the line HA, cutting the line BE, in the point K, so shall KB, be the length of the contrary shadow, which here is found to be 34. degrees and 8 min. or twice so long as your *Gnomon*, and  $\frac{10}{12}$  and about  $\frac{1}{2}$  part of a twelfth more.

CHAP.

CHAP. XV.

*The latitude of the place, the Almicanter, and declination of the Sun being given, to finde the Azimuth.*

*The latitude of the place is 51 degrees, 30 minutes, the declination of the Sun 20 degrees North, the Almicanter 38 degrees 30 minutes, the true Azimuth of the Sun is desired.*



First upon the Centre A draw the Circle B C D E then draw the Diameter B A D, and from D, unto F, set the elevation of the Pole which is 51 degrees, and 30 minutes whose complement is 38 degrees and 30 minutes, which must bee placed from B, unto H, then from H, draw the line H A I, representing the Equinoctiall Line, and from F, draw the line F A G, representing the Pole of the World, then from H, unto P, and from I, unto Q, set the declination of the Sun, which is 20 degrees, and by these two points draw the line P Q, for the Parallell of the Suns declination; then upon the Circle from B, unto H, set the Suns Almicanter, 38 degrees, and 30 minutes, then from H, draw the line H R, Parallell unto the Horizon, cutting the Suns Parallell P O, Q, in O, then draw the Line T V A E, Perpendicular unto the line B A D, in the Centre A, and cutting the line H V R, in V, then set one foot of your  
H com-



the Suns true Azimuth, which is here found to be 72 degrees, and 10 minutes from the South part of the Meridian.

CHAP. XVI.

*The place of the Sun being given to finde the right ascension is desired.*

*Suppose the Sun be in the 20 degree of Taurus, his right ascension is found as followeth.*



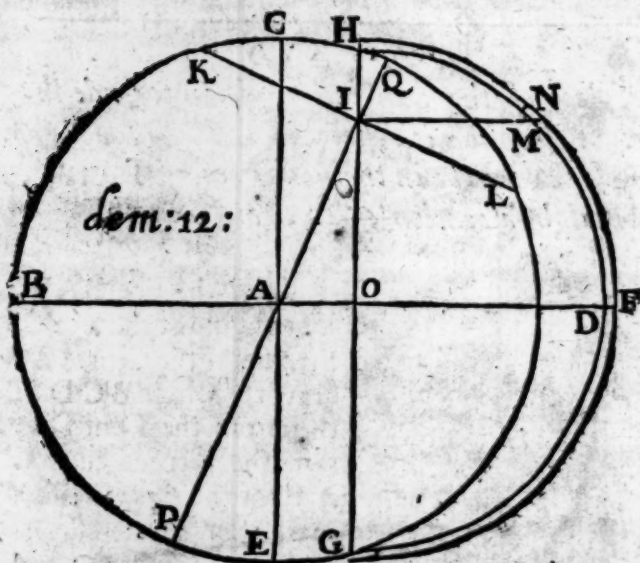
First draw the line B A F, for the Pole of the world, then upon the Centre A, draw the Circle B C D E, then from the Centre A, raise the Perpendicular C A E, for the *Equator*: then place your greatest declination from C, unto Q, and from E, unto P, then draw

the line Q A P, which doth represent the Ecliptick line: then in regard the Sonne is in the 20 degree of *Taurus*, which is 40 degrees, from the head of *Cancer*, which 40 degrees place from Q, unto L, and unto K, then draw the line K L, cutting the Ecliptick in I, then from the point I, draw the line H I, parallel unto C A E, cutting the Pole of the World in O, then set one foot of your Compasses in O, and extend the other unto G, with which distance draw the Semicircle H D G, then opening your Compasses unto the Radius of the Scale, and upon the Centre O, likewise draw the Circle H N F G, then draw the

H 2

line

line  $IM$ , parallel unto  $AOD$ , cutting the Semicircle  $HMDG$ , in  $M$ , then lay your Scale from the



Centre  $O$ , unto the point  $M$ , and draw the Line  $NM$ , cutting the Concentrick Circle in  $N$ , so shall the distance  $NF$ , be the right ascension, which is here found to be 42 degrees, 37 minutes.

CPAD



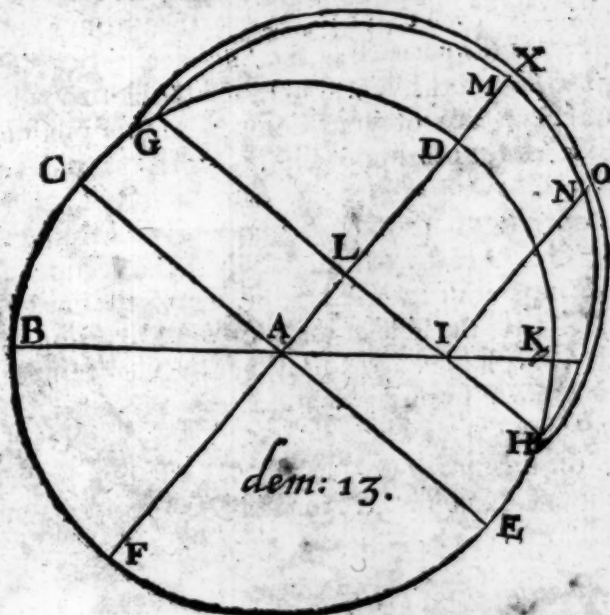
# The Sea-mans Glasse.

53

## CHAP. XVIII.

The elevation of the Pole, and declination of the Sun ;  
given to finde the difference of the ascensions.

The Poles elevation is 51 degrees : 32 minutes, the de-  
clination of the Sun is 21 degrees.



First draw the Line BAK, re-  
presenting the Horizon, then  
upon the Centre A, draw the  
Circle BCDEF, Then from  
K, unto D, set the elevation of  
the Pole which is 51 degrees,  
and 32 minutes : then from the  
point D, by the Centre A, draw  
the line DAF, representing the Pole of the World :  
H 3 then

then from R, unto C, set the complement of the Poles elevation which is 38 degrees, and 26 minutes: then from C, by the Centre A, draw the line CAE, representing the Equinoctial Line; then from C, unto G, and likewise from E, unto H, for the declination of the Sun, which is 21 degrees, then from G, unto H, draw the parallell of the Suns declination, cutting the Pole of the World in L, and the Horizon in I, then set one foot of your Compasses in the point L, and extend the other unto G, then with that distance of your Compasses draw the Semicircle GMNH, then opening your Compasses unto the radius of your Scale, GXOH, then from I, where the declination of the Sun doth cut the Horizon, draw the line IN, parallell unto the Pole of the World AM, cutting the circle GMH, in N, then lay your Ruler from the point I, unto the point N, and so draw the line NO, cutting the Concentrick circle GXOH, in O, so shall the distance of O, and X, be the difference of the ascensions, which is here found to be 28 degrees, and 34 minutes.

CHAP.

CHAP. XVIII.

*The right ascension of the Sun or Starre being given, together with the difference of their ascensions, to finde the oblique ascension.*



He right ascension of any point of the Heavens being knowne, the difference of the ascension is either to be added thereunto or else to be subtracted from it, according as the Starre is situate in the Northerne or Southerne Signes: as for example, if the Sun be in any of these six signes, *Aries, Taurus, Gemini, Cancer, Leo, or Virgo*, then the difference of the ascension is to bee subtracted from the right ascension, and the remainder is the oblique ascension. Suppose therefore the Sunne to be in the fourth degree of *Gemini*, where the right ascension is found to be foure houres, and 8 minutes, or 62 degrees: and the difference of ascension where the Pole is elevated 51 degrees, is found to bee one houre 53 minutes, otherwise 28 degrees 53 minutes, which being taken from the right ascension, leaves two houres, and 16 minutes, or 33 degrees, and 42 minutes, which is the oblique ascension of the Sun in the fourth degree of *Gemini*. But if the Sun be upon the Southside of the Equinoctiall, either in *Libra, Scorpio, Sagitarius, Capricornus, Aquarius, or Pisces*, then the difference of the ascensions is to bee added unto the right ascension, and the Product will be the oblique ascension. Suppose the fourth degree of *Sagitarius*, is given, for which signe and degree the oblique ascension of the Sun is desired,

red,

red, his right ascension being then found to bee 141 degrees, or 16 houres, 8, minutes, the difference of the ascension is one hour, 53 minutes, or 28 degrees, 18 minutes, which being added unto the right ascension, makes 18 houres, and one minute; or in degrees 270 degrees, and 18 minutes: which is the oblique ascension of the Sun, when he is in the fourth degree of *Sagittarius*. And if you would finde the oblique descension, you must adde the difference of the ascensions unto the right ascension, when the Sun is in these six Signes, *Aries, Taurus, Gemini, Cancer, Leo, Virgo*; and contrariwise, when the Sunne is in the other six Signes, you must subtract the difference from the right ascension, and you shal have the oblique descension of the Sun, or any Starre, whose right ascension and difference of ascensions is knowne. But it is to be understood, that this manner of operations doth serve no longer then you are upon the North side of the Equinoctiall. For if the South Pole be elevated, the worke is contrary for so long as the Sun is in any of the Northerne Signes, the difference of the ascensions is to bee added unto the right ascension, to finde the oblique ascension. And contrariwise, subtracted to finde the oblique descension. Likewise if the Sun or Starre be in the Southerne Signes, then is the difference of ascensions, subtracted from the right ascension, to finde the oblique ascension, and added, to finde the oblique descension.



A Description of some peculiar things,  
fit to be considered, by such as intend to  
practise the Art of Navigation,  
or Astronomie.



THE Zenith is an imaginary point in the Heavens over our heads, making right Angles with the Horizon, as the Equinoctial maketh with the Pole.

The Nader is a prick in the Heavens under our feet, making right Angles with the Horizon under the earth; as the Zenith doth above; and therefore is opposite unto the Zenith.

The declination of the Sun, is the Arke of a Circle contained betwixt the Ecliptick and the Equinoctial, making right Angles with the Equinoctial. But the declination of a Starre, is the Arke of a Circle let fall from the Centre of a Starre, perpendicularly unto the Equinoctial.

The Latitude is the Arke of a Circle contained betwixt the Centre of any Star, and the Ecliptick Line



making right Angles with the Ecliptick, and counted either Northward, or Southward, according to the Situation of the Star, whether it bee nearer unto the North or South Pole of the Ecliptick.

The Latitude of a Town or Countrey, is the height of the Pole above the Horizon, or the distance betwixt the Zenith and the Equinoctiall.

The Longitude of a Star, is that part of the Ecliptick, which is contained betwixt the Starrs place in the Ecliptick, and the beginning of *Aries* counting them from *Aries* according to the succession or order of the Signes.

The Longitude of a Towne or Countrey are the number of degrees, which are contained in the Equinoctiall, betwixt the Meridian that passeth over the Isles of *Azores*, (from whence the beginning of Longitude is accounted) Eastwards, and the Meridian that passeth over the Town or Countrey desired.

The Altitude of the Sun or Star, is the Arch of a circle contained betwixt the Centre of the Sun, or any Star, and the Horizon.

The Amplitude is that part of the Horizon which is betwixt the two East or west points and the point of the Compass that the Sun or any Star doth rise or set upon.

Azimuthes are Circles; which meet together in the Zenith, and crosse the Horizon at right Angles, and serve to finde the point of the Compass, which the sun is upon at any houre of the day, or the Azimuth of the Sun or Star, is a part of the Horizon contained betwixt the true East or West point, and the Azimuth which passeth by the Centre of the same Starre to the Horizon.

The right ascension of a Star, is that part of the Equinoctiall, which is contained betwixt the first point of *Aries* and the Star.

Equinoctiall that riseth or setteth with the Star, in a right Sphere, or in an oblique Sphere, it is that portion of the Equinoctiall, contained betwixt the beginning of *Aries*, and that place of the Equinoctiall, which passeth by the Meridian with the centre of the Starre.

The oblique ascension is a part of the Equinoctiall contained betwixt the beginning of *Aries*, and that part of the Equinoctiall that riseth with the centre of a Starre, in an oblique Sphear.

The difference ascensionall, is the difference betwixt the right and oblique ascension: or it is the number of degrees contained betwixt that place of the Equinoctiall that riseth with a Centre of a starre, and that place of the Equinoctiall that cometh unto the Meridian, with the Centre of the same star.

*Almicanters*, are Circles drawne parallell unto the Horizon, one over another untill you come unto the Zenith: these are Circles that do measure the elevation of the Pole, or height of the Sun, Moone, or Stars above the Horizon, which is called the *Almicaster* of the Sun, Moon, or Star: the *Arke* of the Sun or Stars *Almicaster*, is a portion of an Azimuth contained betwixt that *Almicaster* which passeth thorough the centre of the star, and the Horizon,



A generall Table for the Tides in all places.

The Moons Houres and Minute age. to be added.			The Moons Houres and Minutes age. to be added.		
Dayes.	Degrees.	Minutes.	Dayes.	Degrees.	Minutes.
1	0	48	16	0	48
2	1	36	17	1	36
3	2	24	18	2	24
4	3	12	19	3	12
5	4	0	20	4	0
6	4	48	21	4	48
7	5	36	22	5	36
8	6	24	23	6	24
9	7	12	24	7	12
10	8	0	25	8	0
11	8	48	26	8	48
12	9	36	27	9	36
13	10	24	28	10	24
14	11	12	29	11	12
15	12	0	30	12	0

The use of the Table of the Tides.



First It is to be understood, that by the swift motion of the first mover, the Moon and all the rest of the Stars and Planets, are turned about the World in 24 houres, upon which swift motion of the Moon, the dayly motions of the Sea do depend, which motion of the Sea fall not out alwaies at one houre, the

the reason thereof is, because of the swift motion of the Moon in regard she goeth almost 13 degrees in 24 houres, and the Sun mooveth scarce one degree: which gives every day 12 degrees, that the Moone commeth slower to any point in the Heaven then the Sunne: which 12 degrees, makes 48 minutes of time for the difference of every full Sea, according unto the middle motion of the Moone. which difference is here set downe in this Table for every day of the Moons age. Therefore if you would know the full Sea at any place in the World, first you must know at what houre it is full Sea at the new or full Moon; which hours and minutes keep in mind, then seeke the age of the Moon as is before taught, and with the number of her age enter this Table, under the title of the Moons age, and having found her age in the Table, against it you shall find the houres and minutes which are to be added unto the time that the Moon maketh full Sea in any place, and the whole number of houres and minutes is the time that the Moon maketh full Sea in any place upon the day desired. As for ensample, I desire to know the full Sea at *Bendon* bridge upon the 13 of *July* 1624. the age of the Moon being found as before, is eight daies, then in the Table I find eight daies and against it 6 houres, and 24 minutes, which being added unto 3 houres, the full Sea upon the change day gives 9 a clock, 24 minutes for the time at the full Sea upon the 13 day of *July* 1624.

*FINIS.*





